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Ft. Hood iScout to Persistent Ground Surveillance System (PGSS) Cueing Demonstration

by Thomas W. Walker

ARL-MR-0783 **June 2011**

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14. ABSTRACT

The 504th Battlefield Surveillance Brigade (BfSB) certification exercise (CERTEX) was held at Ft. Hood, TX, February 28 to March 11, 2011, in preparation for their deployment to theater. At the request of Don Nibblett and the Army G-2 office, the U.S. Army Research Laboratory (ARL) was asked to conduct training classes for Soldiers using iScout sensors, as well as demonstrate the "slew to cue" capability of the Persistent Ground Surveillance System (PGSS) using iScout sensors as detection triggers. This memorandum report chronicles the technical aspects and challenges of the successful exercise at Ft. Hood and provides recommendations for future testing.

15. SUBJECT TERMS

iScout, PGSS, unattended ground sensor, persistent surveillance, cueing, trigger sensor

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- the Army G-2 office for supporting the iScout to the Persistent Ground Surveillance System (PGSS) slew-to-cue demo at Ft Hood, TX;
- Don Nibblett for his patience and understanding in dealing with all the issues and challenges that needed to be resolved;
- Mike Brunda, Shane Nguyen, and Mark Anderson for training the Soldiers and setting up and operating the ARL equipment;
- Brent Roeder for making sure the iScout, the Tactical Situation Awareness Display (TacSAD), and repeater equipment were installed and operating properly as well as coming up with our alternative plan B;
- Colin McCabe for supporting the Unattended Transient Acoustic MASINT System (UTAMS) software; and
- Aubrey Taylor, Ru Kirschner, and the entire PGSS crew for all their help with the aerostat and Airborne Global Information Grid (AGIG) link.

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1. Overview

The 504th Battlefield Surveillance Brigade (BfSB) certification exercise (CERTEX) was held at Ft. Hood, TX, February 28 to March 11, 2011, in preparation for deployment to theater. At the request of Don Nibblett and the Army G-2 office, the U.S. Army Research Laboratory (ARL) was asked to conduct training classes for Soldiers using iScout sensors, as well as repeat the demonstration of "slew to cue" of the Persistent Ground Surveillance System (PGSS) using iScout sensors as detection triggers. As was the case with the Ft Huachuca, AZ, demo, this exercise involved cooperation from several groups including the program manager (PM)-PGSS for providing the aerostat and ground support, McQ for iScout and Situational Awareness Display Unit (SADU) support, ElanTech for Unattended Transient Acoustic MASINT System (UTAMS) controller support, Ft. Hood for base support, and the Army G-2 office for funding the effort. Figure 1 presents a diagram of the overall system and shows the sequence of events and data flows initiated by an iScout sensor target detection and culminating with the PGSS video stream arriving at the Tactical Operations Center (TOC).

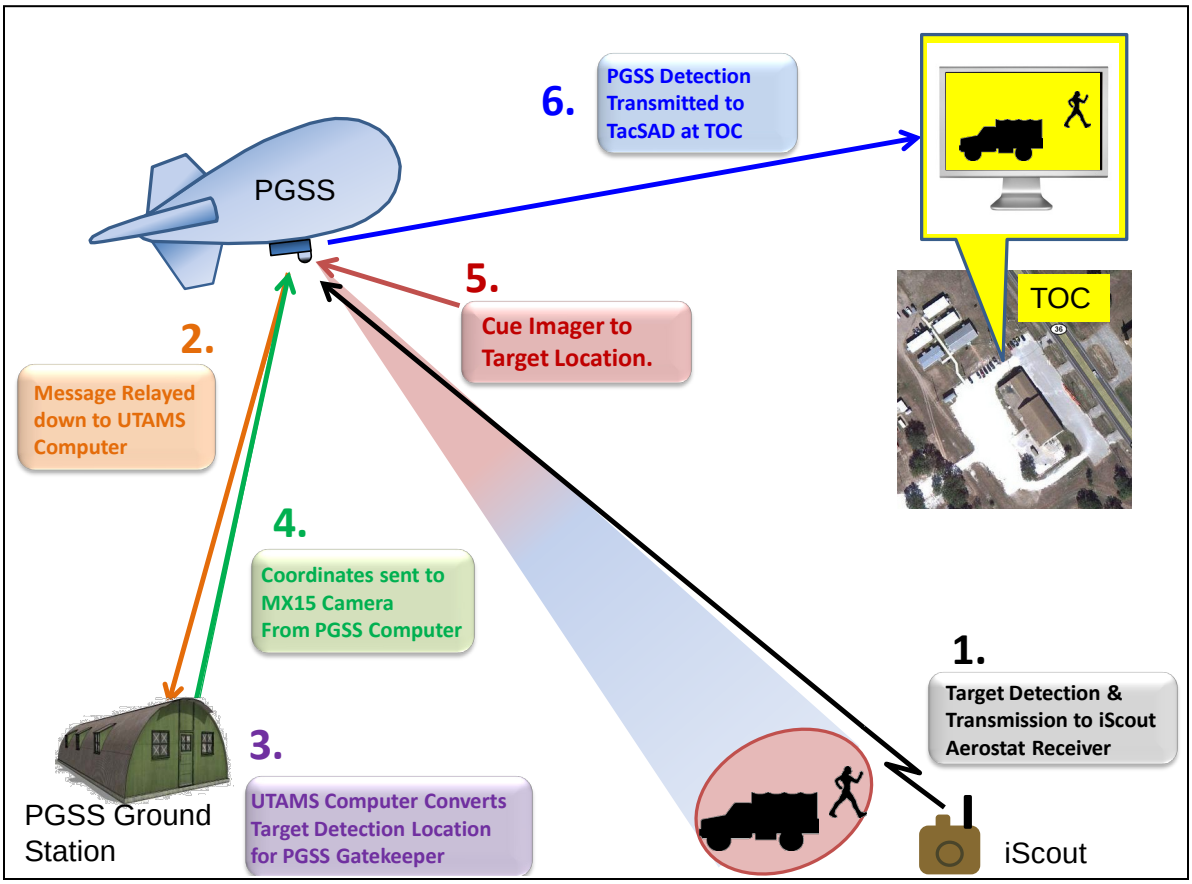

Figure 1. Block diagram of iScout to PGSS cueing demonstration at Ft Hood, TX.

2. Experiment Details

On Thursday, March 3, the team met with Don Nibblett at the TOC, which was located on the north end of Ft. Hood near Gatesville, TX. The day's activities were discussed, the equipment needed to run the demo was picked up, and then we went to the aerostat site. The aerostat was already flying, so Nibblett arranged to have it lowered so we could install the base station repeater and antenna that would communicate with the emplaced iScouts. The equipment was set up on the ground and checked out before installation on the aerostat (figure 2). The winds picked up significantly as the team waited for the aerostat crew to finish their day's testing. By the time the aerostat was moored on the trailer, it was moving about vigorously enough that it was deemed unsafe to attempt to install the equipment or raise it back up to begin testing, so the PGSS crew was dismissed for the day.

Figure 2. Setup and testing of the equipment at the PGSS aerostat site.

On Friday morning, the winds were still above the recommended level for launching the aerostat (more than 15 mph at ground level), but we were able to attach the base station repeater and antenna to the aerostat gondola (figure 3). A full checkout of the system on the ground was performed including the following:

- We triggered an iScout located in the aerostat parking area.
- We logged receipt of the iScout cue by the base station repeater.
- We confirmed the relay of the iScout cue to the UTAMS controller.

- The UTAMS controller processed the message and forwarded it to the PGSS Gatekeeper, which issued a camera position command.
- The PGSS camera slewed to the location of the iScout in the parking area.

Figure 3. Installation of the equipment on the PGSS aerostat gondola.

Unfortunately, high wind conditions prevented the aerostat from being launched, so we drove to the TOC and made provisions for getting AC power and installing the Tactical Situation Awareness Display (TacSAD) and other equipment necessary to view detection reports.

On Saturday, March 5, it was again too windy to launch the aerostat. We drove to the TOC and met Mark Anderson outside the training tent and gave him additional iScout equipment to assist with training the 504th brigade team. Three areas were set up for training the Soldiers on how to use the iScout, the Current Force Unattended Ground Sensors, and the Weapon Surveillance System (figure 4). We went inside the TOC and met with Aubrey Taylor, the technical lead for the PGSS team. After locating suitable AC power, Brent Roeder connected the TacSAD toughbook computer to the Airborne Global Information Grid (AGIG), a wireless, high-data-rate and Internet-protocol-based network. In addition, the MPEG4 video stream from the AGIG needed to be converted to MJPEG video format for the TacSAD, so a video converter and server were used, as shown in figure 5.

Figure 4. Soldier training tent.

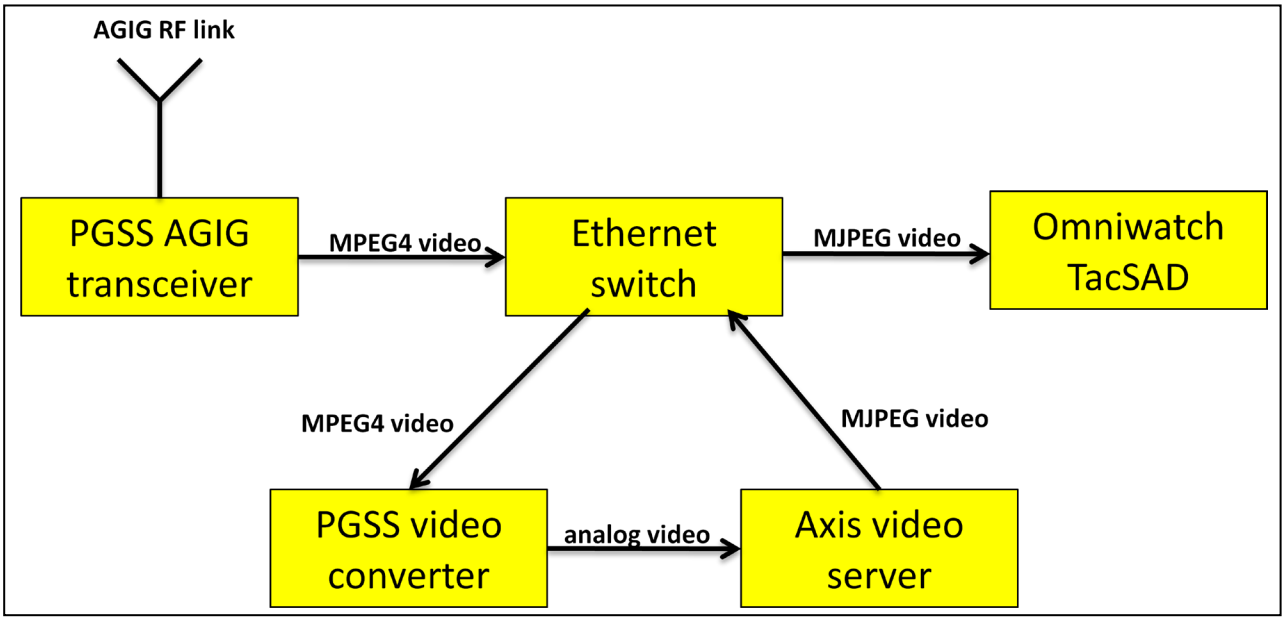

Figure 5. Block diagram of the conversion of MPEG4 video to MJPEG video format.

The TacSAD system began receiving video from the TOC AGIG network, albeit a blank screen as the aerostat camera was stowed. After more testing at the TOC to make sure the system was working, we shut down and went to the aerostat site to view the stored video clips that the PGSS camera took of the training area near Highway 36 (called Jalalabad). These stored clips illustrated where the best location was to emplace the iScouts in order to ensure that line of sight

to the aerostat would be maintained (figure 6). After looking over several movie clips, we drove back to the TOC to discuss emplacement strategy with Nibblett, who already had a good idea from scouting the Jalalabad site earlier with his team of where to put the sensors. Nibblett disclosed that his team would emplace two iScouts in Jalalabad later that evening. These sensors were configured for seismic mode and set to high sensitivity for detecting personnel and low sensitivity for detecting vehicles. One iScout was buried near Highway 36 and the other near the hilltop water tower (figure 7).

Figure 6. Reviewing the aerostat camera video clips at the PGSS ground station.

Figure 7. Map showing the placement of iScout sensors at the Jalalabad training site.

On Sunday, March 6, we arrived at the PGSS aerostat site and mounted a higher-gain antenna for the base station repeater on the camera gondola (figure 8). We then connected the antenna cable to the base station repeater, booted up the UTAMS controller, connected the TacSAD to the network to view the sensor detections, and turned on an iScout and triggered it. The system properly received and processed the iScout trigger message and the aerostat camera slewed to the iScout location in the parking lot. All systems operated properly so the crew began raising the aerostat to 2000 ft (figure 9).

Figure 8. High-gain repeater antenna mounted on the PGSS camera gondola.

Figure 9. PGSS aerostat.

As the aerostat reached an elevation of about 1500 ft, it began receiving detections from the iScout that was emplaced that morning at the TOC just outside the training tent. The iScout was set to passive infrared (PIR) mode and was placed on top of the ground looking out at the road. However, only a single detection was received from the sensors at Jalalabad while the aerostat

was on the way up and none were received after the aerostat reached 2000 ft. Detections continued to arrive from the iScout at the TOC. Unsure as to why we were not receiving detections from the Jalalabad sensors, we sent Mike Brunda and Shane Nguyen to investigate. They replaced the batteries in the HW36 iScout and triggered it several times and monitored the detections using a Wireless Mobile Relay (WMR) and Handheld Programming Module (HHPM). Unfortunately, the detections were still not received by the aerostat repeater. In addition, the PGSS aerostat camera quit working; the crew attempted to reboot it several times to no avail. The aerostat was lowered so the crew could inspect the equipment and we took the opportunity to try another mounting location for the repeater antenna. We moved it from the camera gondola to the controller frame in hopes that this new location would allow reception of signals from the Jalalabad sensors (figure 10).

Figure 10. Mounting site for the repeater antenna on the PGSS controller frame.

After testing the aerostat camera, the PGSS crew declared that it was inoperative and that a new camera would need to be ordered. The aerostat was raised to 2000 ft so that our team could run additional testing to see if we could make the Jalalabad link with the new repeater antenna mounting location. Again, we received messages from the sensor at the TOC, but not from Jalalabad. We turned on and initialized a second repeater that had been brought hoping that the 1-W repeater would be able to cover the 7-km distance from where the iScouts were near Highway 36 to the aerostat, versus the ½-W iScouts. While this repeater properly received detections from both sensors at Jalalabad, it was unable to make the radio frequency (RF)

connection to the aerostat. Strangely, the aerostat repeater could ping the Highway 36 repeater fairly reliably, but the returned acknowledge message from the Highway 36 repeater generally failed to be received. Figure 11 shows a map of Ft. Hood and the locations of the iScout at the training tent at the TOC, the iScouts at Jalalabad, and the aerostat site (distance scale on lower left corner). At this point, we had exhausted our options to establish the Jalalabad to aerostat link, so the PGSS crew lowered the aerostat and everyone called it a day.

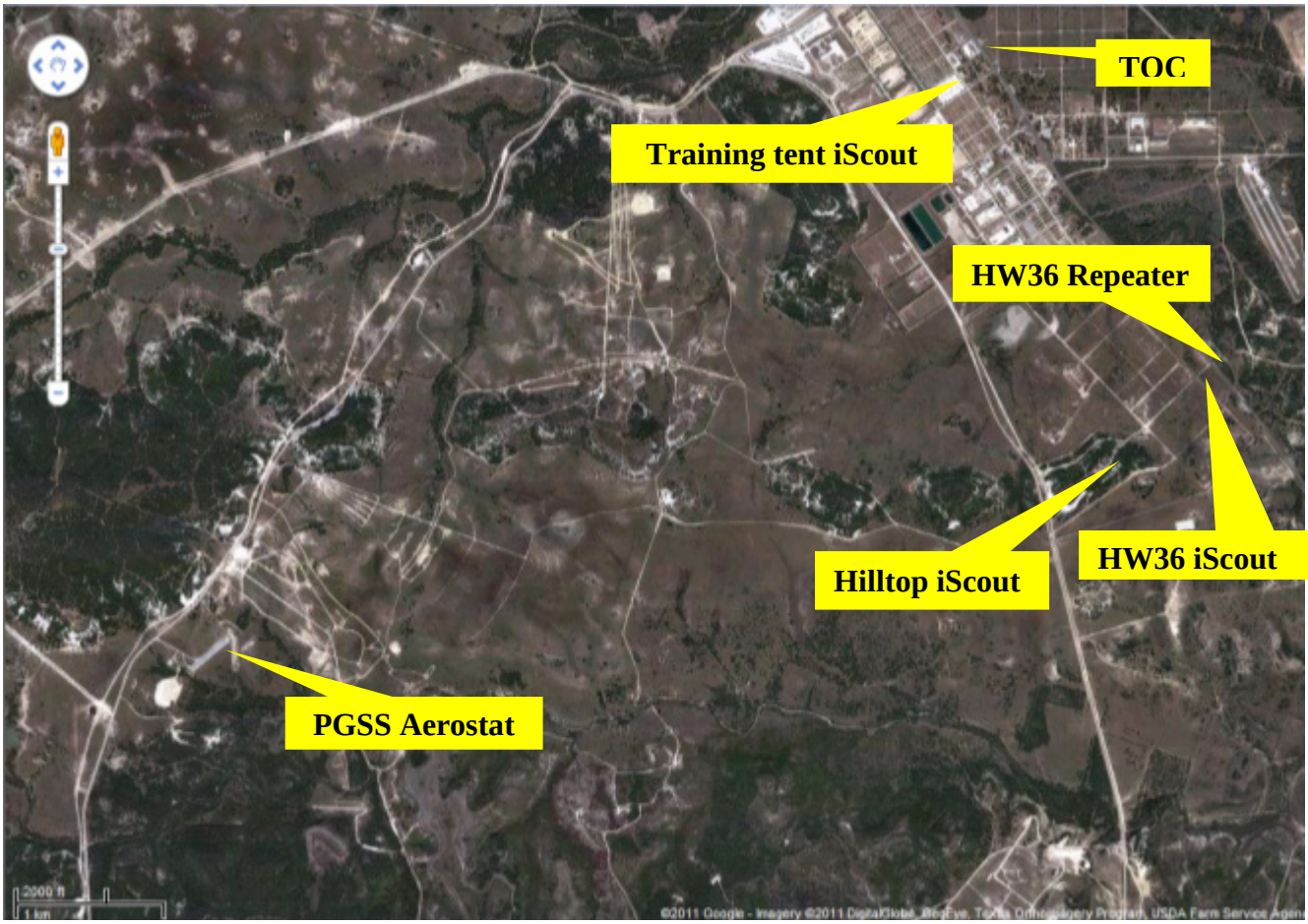

Figure 11. Map showing the locations of the aerostat and sensors.

On Monday morning, March 7, we held a telecom with McQ engineers to discuss the previous day's test results and potential ways to increase the range of the iScout sensors. Several options were discussed including using a new location for the Jalalabad repeater, using a high-gain directional antenna for the repeater (one cannot use such an antenna on the aerostat since it rotates in the wind), using a filter on the aerostat repeater to block unwanted signals, and finding a new mounting location for the aerostat base station repeater antenna. McQ decided to overnight ship additional equipment that would arrive the following day and continued to review the log file data in the hopes of gaining additional insight into the problem. The winds kicked up again overnight making it unlikely the aerostat could be raised, so we met Nibblett at the TOC.

We decided to scout the Jalalabad hilltop area for a suitable repeater site. We checked the hilltop iScout, replaced the two AA batteries and exchanged the stub antenna with a whip antenna on a 6-ft cable and strung it up in a juniper bush. We also scouted the hilltop area for a good repeater location that had line of sight to the aerostat as well as to the HW36 and hilltop iScouts. We located a suitable spot near the front of the hill and were able to receive detections from both iScouts using the WMR and HHPM (figure 12). After the day's activities were over, we stopped at the local Home Depot to pickup hardware for mounting the high-gain whip antenna to the 10-ft repeater mast.

Figure 12. Scouting the hilltop area of Jalalabad for a suitable relay site.

Tuesday, March 8, the winds were still too strong to fly the aerostat. We retrieved the equipment shipped overnight from McQ and traveled to Jalalabad to emplace the hilltop repeater. We mounted the high-gain whip antenna on the 10-ft mast at the desired location and connected the antenna cable to the repeater and battery box (figure 13). We used a laptop connected to the serial port on the repeater to monitor messages from the iScouts and were able to receive detections from both sensors.

Figure 13. Installing the Jalalabad hilltop repeater.

The hilltop repeater-to-aerostat RF link was now the only component we still needed to test, but windy conditions again prevented the aerostat from flying. We returned to the TOC where Nibblett had emplaced a WMR in the training tent, which was now receiving detections from the two Jalalabad iScouts, which were about 2.5 km away. We discussed the possibility of moving the base station repeater antenna from the PGSS aerostat controller cage to a new location about 2 m towards the tail. Both Taylor and Ru Kirschner (the PGSS ground crew leader) agreed this would be fine. We did not attempt to make the change as the wind was moving the aerostat around too much. A technician had arrived to work on the camera and discovered that the gimbal controller board was causing the problem (figure 14). Kirschner and Taylor left to pick up the new camera that had just arrived on base and we returned to the TOC. Brunda and Nguyen discovered that the HW38 iScout had quit transmitting detections, so they drove out to Jalalabad and installed fresh AA batteries. We discovered that each iScout will process about 500 detections before the two AA batteries are completely drained. The HW36 iScout is close enough to the highway to pick up large vehicles driving by, thus draining the battery much sooner than expected.

Figure 14. Technician troubleshooting the PGSS aerostat camera.

Wednesday, March 9, it was again too windy to fly. We watched the PGSS crew install the new camera on the aerostat gondola and run system checks before energizing the entire system. The new camera failed to initialize properly and shut down just like the previous one. The gondola was removed and the technician went to work diagnosing the problem with the new camera. The 504th practice exercise at Jalalabad was scheduled for today and the live run tomorrow; the last day of the CERTEX. Nguyen took over running the iScout training classes from Anderson who needed to return home (figure 15); Colin McCabe planned to leave the following day since the UTAMS system was operating as expected.

Figure 15. Nguyen assisting 504th Soldiers outside the training tent.

With Nibblett's approval, Roeder started working on an alternative approach in case the hilltop repeater-to-aerostat RF link failed tomorrow. A WMR was set up in the 2nd floor window at the TOC facing in the direction of Jalalabad. A Bluetooth wireless connection from the WMR to the TacSAD laptop was used to receive detections from either the two Jalalabad iScouts or the hilltop repeater about 2.5 km away (figure 16). The iScout detections were routed through the Ethernet port and sent over the AGIG link to the aerostat. When the aerostat is elevated (and line of sight to the TOC achieved), the commands will be received and sent to the UTAMS controller in the ground station, where they will be converted into camera slewing commands for the PGSS Gatekeeper. This alternative plan worked as far as we could test it without having the aerostat in the air. The camera repair technician was able to make one camera operational by scavenging parts from both cameras.

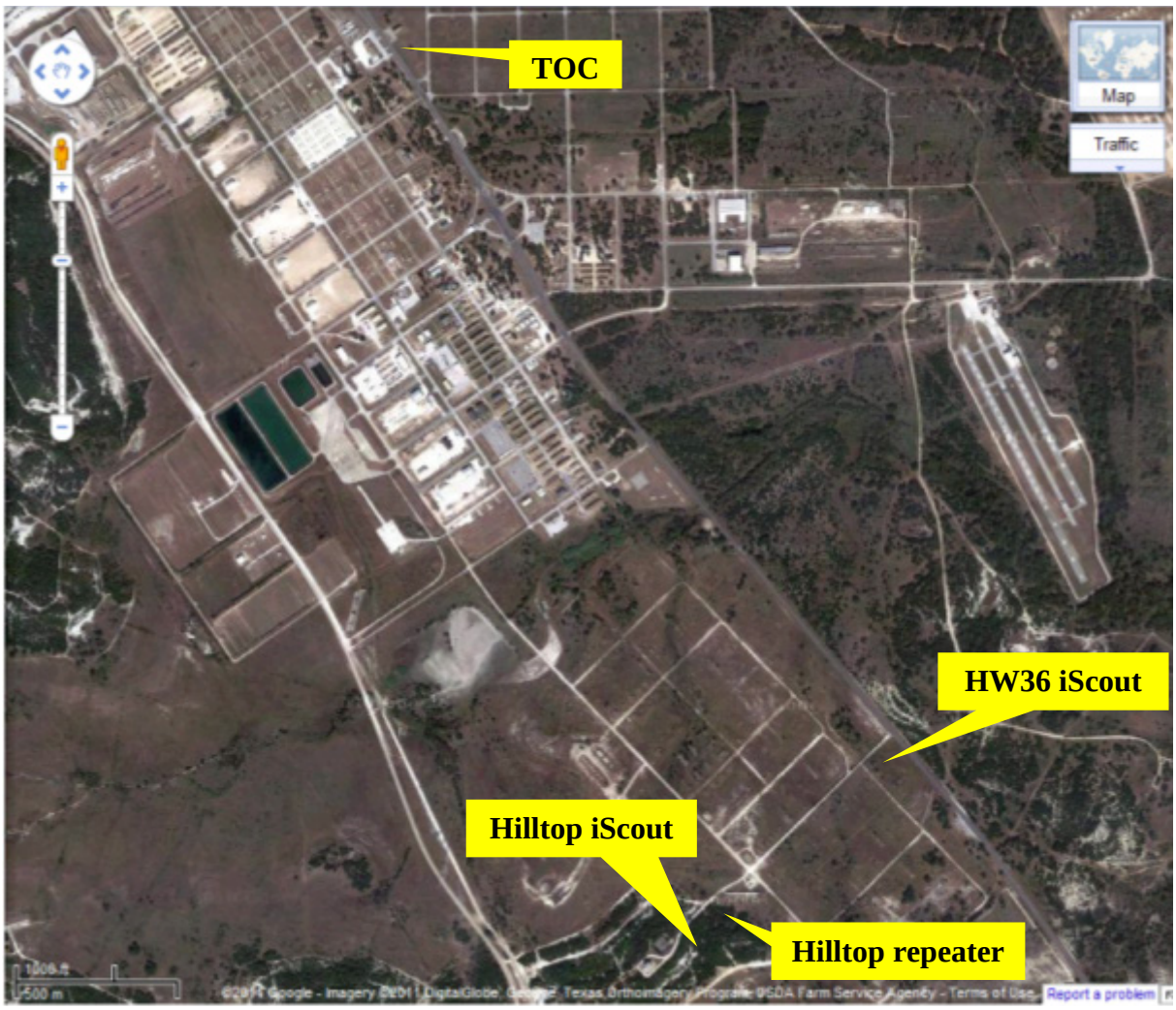

Figure 16. Map location of the Jalalabad sensors, hilltop repeater, and TOC.

Thursday, March 10, the wind had finally subsided and we mounted the high-gain whip antenna aft of the PGSS controller and installed the bandpass filter (figure 17).

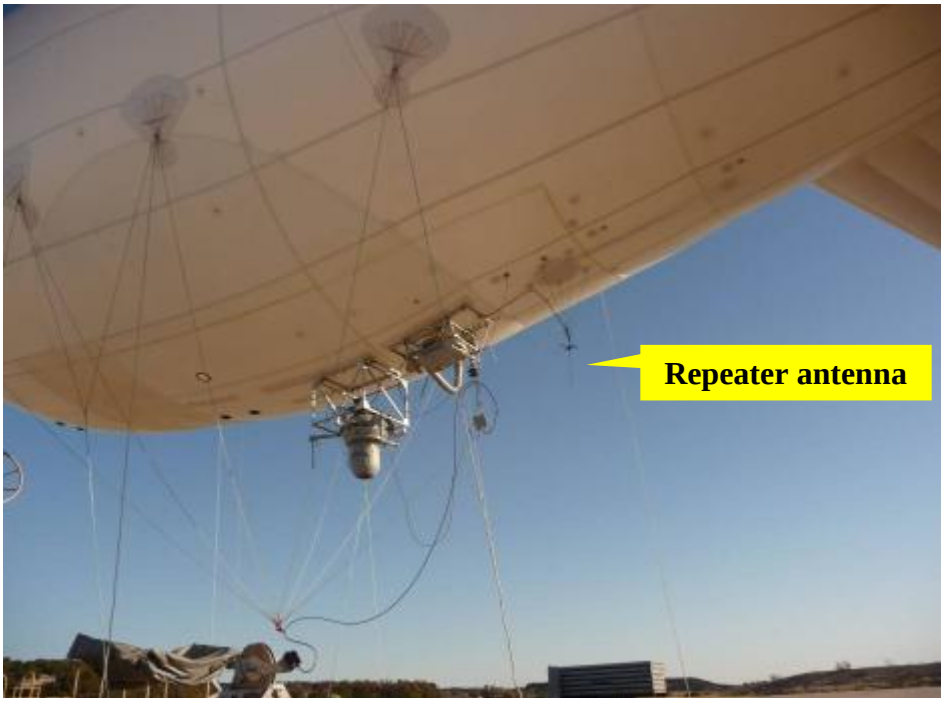

Figure 17. Aerostat repeater antenna rear mounting location.

We performed a complete system check with the aerostat on the ground and the camera successfully slewed towards the iScout placed near the vehicles. The crew raised the aerostat and the camera worked properly. However, even when the aerostat reached 2000 ft, we could not receive signals from the hilltop repeater. We replaced the iScout batteries and triggered both sensors, but still no detection reports were received from the hilltop repeater (figure 18).

Figure 18. Monitoring iScout detection reports with TacSAD at the PGSS ground station.

We switched to the alternative plan "B" and installed the WMR in the window, set up the TacSAD laptop, and routed the detections from the Jalalabad iScouts through the AGIG link to the aerostat, which then sent them to the UTAMS controller, which, in turn, issued camera slewing commands to the aerostat camera. The HW36 iScout was triggered and within 2 s the camera slewed to that precise location—success at last! During Nguyen's training classes, as students turned power on and triggered iScout sensors, the aerostat camera would slew to the location of the training tent and away from Jalalabad. We used these sensor triggers and the ones initiated by Brunda at Jalalabad to verify that the slew to cue was operating properly. After we were confident the system was operating properly, the sensors at the training tent were switched from channel 1 to 4 so their triggers would not interfere with the sensors at Jalalabad and the troop exercise. The 504th MI brigade held their mission planning session in the morning and their live CERTEX in the afternoon. The 504th Warfighters were able to take advantage of the cue-to-slew capability and received live PGSS video feeds on handheld displays (eSAT system) as the Opposing Force (OPFOR) maneuvered around Jalalabad and triggered the iScouts. MG Legere (Commander of U.S. Army Intelligence & Security Command) observed some of the 504th live exercises at Jalalabad and witnessed the slew-to-cue capability.

3. Conclusion and Recommendations

The iScout and PGSS slew-to-cue capability was successfully demonstrated at Ft Hood, TX, during the last day of the two-week 504th BfSB CERTEX. The two major challenges we faced during the exercise were (1) attempting to make a reliable RF link of about 7 km between the iScout sensors and the PGSS aerostat, and (2) windy conditions that only allowed the aerostat to fly 2½ of the 8 days we had on site, which severely limited our testing capability.

Future use of the iScout and PGSS system should include a Concept of Operations (CONOPS) that specifies (1) how to set up the system, (2) where to mount the antenna and repeater on the aerostat, and (3) the maximum distance allowed from the sensors to the aerostat.

This system would probably be of limited value in areas with high wind conditions as the aerostat would be grounded most of the time, unless it could be modified to withstand these windy conditions.

The use of a high-gain directional antenna, like a parabolic dish or Yagi coupled to a repeater, would be beneficial for extending the range between the sensor field and the aerostat, keeping in mind the antenna beam must simultaneously cover the sensor field and the aerostat.

On a few occasions during our final day of testing, the PGSS camera slewed to a location near the sensors and the operator had to manually adjust the camera's aim point. This was probably caused by the wind vigorously shifting the aerostat around and causing it to temporarily lose the precise bearing required for pointing the camera over such long distances.

List of Symbols, Abbreviations, and Acronyms

AGIG	Airborne Global Information Grid
ARL	U.S. Army Research Laboratory
BfSB	Battlefield Surveillance Brigade
CERTEX	certification exercise
CONOPS	Concept of Operations
HHPM	Handheld Programming Module
OPFOR	Opposing Force
PGSS	Persistent Ground Surveillance System
PIR	passive infrared
PM	program manager
RF	radio frequency
SADU	Situational Awareness Display Unit
TacSAD	Tactical Situation Awareness Display
TOC	Tactical Operations Center
UTAMS	Unattended Transient Acoustic MASINT System
WMR	Wireless Mobile Relay

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